Space Weather Technical Forecast

Issued on Tuesday, 14 November 2023 at 12:11 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of M-class flares, risk declining through the period. Slight Chance of a G1/Minor Geomagnetic Storm on Days 1 and 2 (14-15 Nov). Chance of fluence increasing to Active levels (1e8 integrated pfu).

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Solar activity has been Low, with occasional C-class flares in the last 24 hours. There are five sunspots currently on the visible solar disc, all of which lie in the western hemisphere. AR3483 close to the northwestern limb is the largest region but can no longer be clearly seen. AR3484 and AR3485 are both near the southwest limb and are also becoming difficult to assess, although AR3485 is showing some signs of developing minor magnetic complexity. AR3486 and AR3487 are both relatively straightforward at the present time.
No Earth-directed CMEs have been observed in available imagery over the past 24 hours.
Solar Wind / Geomagnetic Activity: Solar winds, as observed at L1 by ACE and DSCOVR, showed declining CME effects, perhaps with a second weak CME arrival around 13/1620 UTC. Wind speeds were mostly at slightly elevated levels between 380-480 km/s. Density was initially above average but soon declined to average or below. The total magnetic field strength (Bt) was initially weak but became moderate at 13/1620 UTC. The north-south component (Bz) was weakly negative at first, gradually becoming positive, moderately so at times. The phi angle was mostly positive (away from the Sun), gradually turning mostly negative (towards the Sun). Geomagnetic activity has been Quiet to Unsettled (Kp 0-3).
Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux remained at background levels. GOES16 high energy (greater than 2MeV) electron flux was at mostly background levels. The associated 24-hour fluence was below the Active (1e8 integrated pfu) threshold, initially on a steeply declining trend but now steady. The fluence observation at 14/0000UTC was 3.71e6 integrated pfu.

Four-Day Space Weather Forecast Summary
Solar Activity: Solar activity is likely to remain at Low levels, with a chance of M-class flares at first. The probability of M-flares gradually declines through the period as several sunspot regions rotate off of the disc. No significant new or returning regions are expected to rotate onto the visible disc during the next four days.
Solar Wind / Geomagnetic Activity: A slow CME may give a glancing blow on Day 2 (15 Nov). Impacts are expected to be very limited in association with this low probability potential arrival. Current solar wind speeds have declined to around 380 km/s, likely under weak CME influence. This is expected to continue to wane through Day 1 (14 Nov). A further small equatorial coronal hole, CH70/-, may cause a slight enhancement to solar winds on Days 2-3 (15-16 Nov), with the HSS perhaps coinciding with the glancing CME.
Geomagnetic activity is expected to be largely Quiet to Unsettled (Kp 0-3). There is a chance of Active (Kp 4) intervals and a slight chance of an isolated G1/Minor Geomagnetic Storm (Kp 5) on Day 1 due to declining CME effects, should the Bz turn south, and again on Day 2 if there is combined CME and HSS influence.
Energetic Particles / Solar Radiation: There is a slight but declining chance of S1/Minor Radiation Storm conditions during the period should any sunspot regions produce significant

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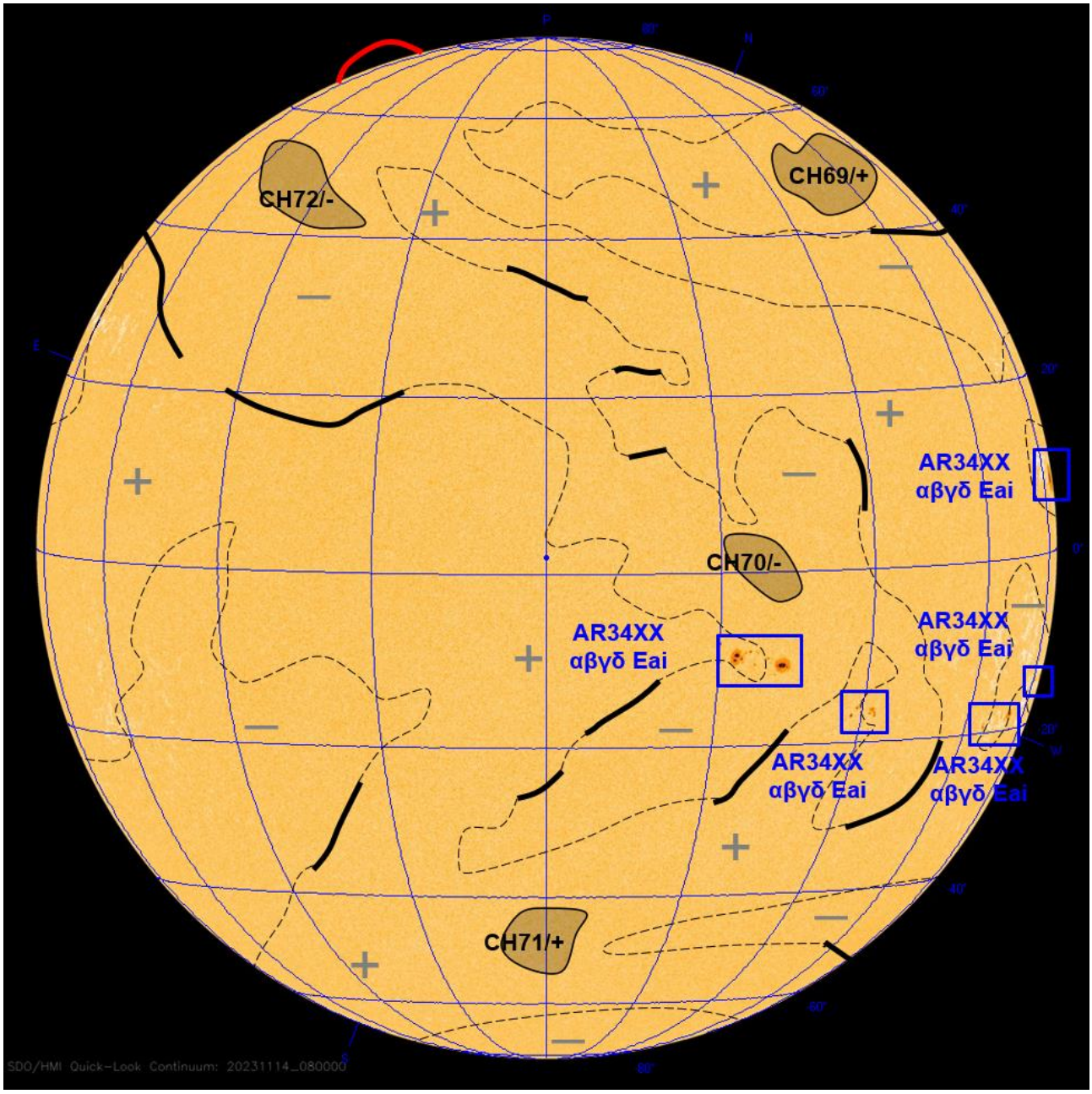
flares. Probabilities begin to wane later in the period as these regions rotate well beyond the western limb.
The electron flux is now at background levels. There is low confidence in the behaviour of the electron flux in the coming days, but a recovery in values is possible, perhaps reaching high levels. Electron fluence may increase again over the coming days, perhaps returning to Active levels.

Figure 1. Solar Analysis Valid 14/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A slow CME observed leaving the Sun around 10/1930 UTC may give a glancing blow on Day 2 (15 Nov). However, MOSWOC Enlil modelling would suggest that the bulk of the CME will miss ahead. The source region of this CME appears to be an eruption following a dimming event and flare from the southwest quadrant in the vicinity of AR3484 and AR3485. Impacts are expected to be very limited in association with this low probability potential arrival. No other Earth-directed CMEs are in the current forecast.

Current solar wind speeds have declined to around 380 km/s, likely under weak CME influence. This is expected to continue to wane through Day 1 (14 Nov). A further small equatorial coronal hole, CH70/-, may cause a slight enhancement to solar winds on Days 2-3 (15-16 Nov), with the HSS perhaps coinciding with the glancing CME.

Geomagnetic activity is expected to be largely Quiet to Unsettled (Kp 0-3). There is a chance of Active (Kp 4) intervals and a slight chance of an isolated G1/Minor Geomagnetic Storm (Kp 5) on Day 1 due to declining CME effects, should the Bz turn south, and again on Day 2 if there is combined CME and HSS influence.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	5	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
11/0633	Partial	Dimming / filament	SW disc near AR3484	378 km/s	15/1200 +/- 12 hours	Glancing blow. Low confidence.

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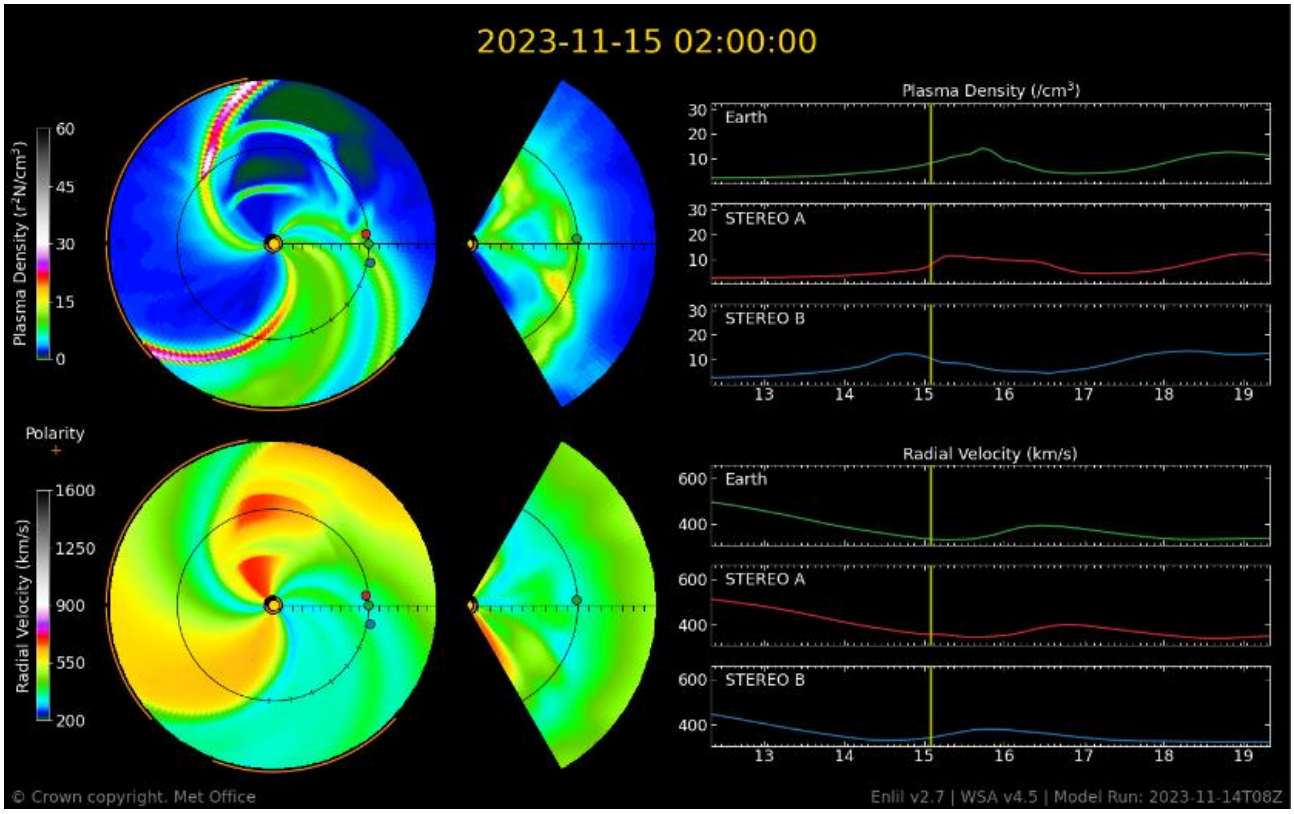
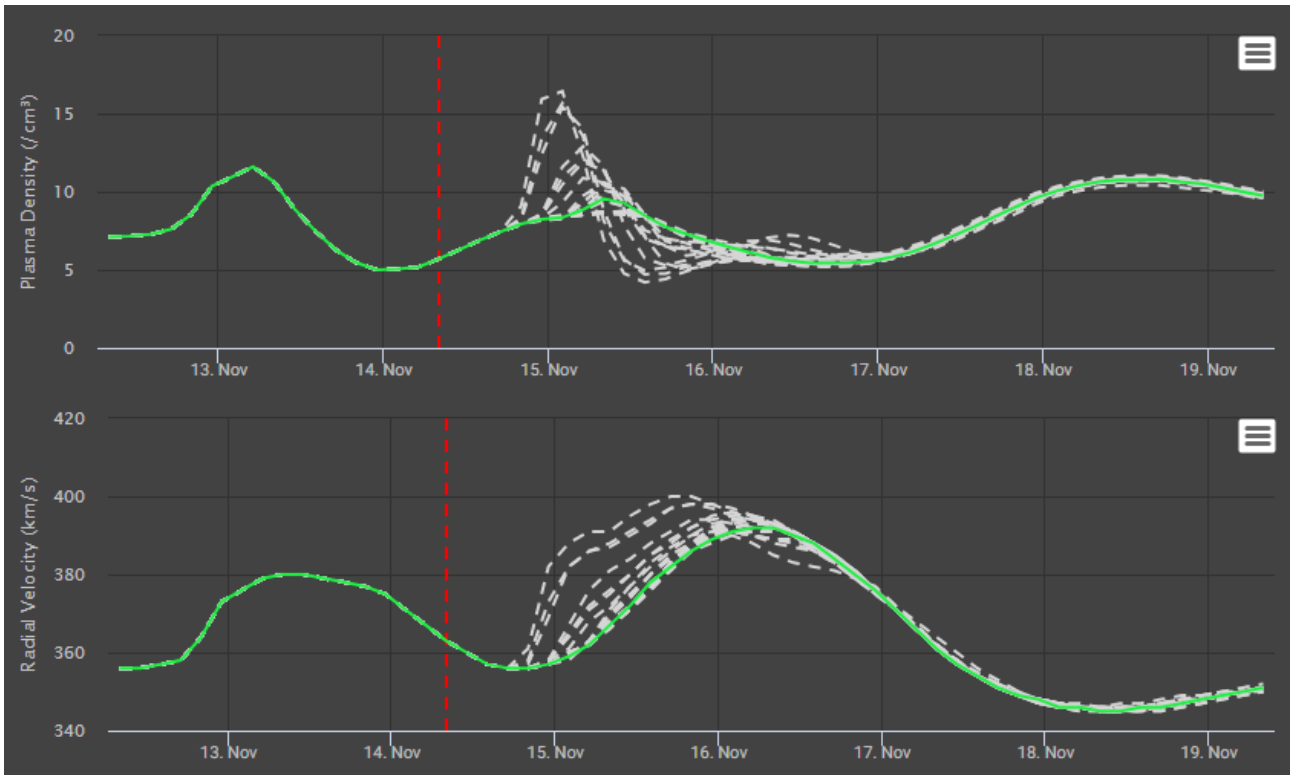
Figure 2: MOSWOC Enlil and ensemble, showing possible CME arrival on 15 November.





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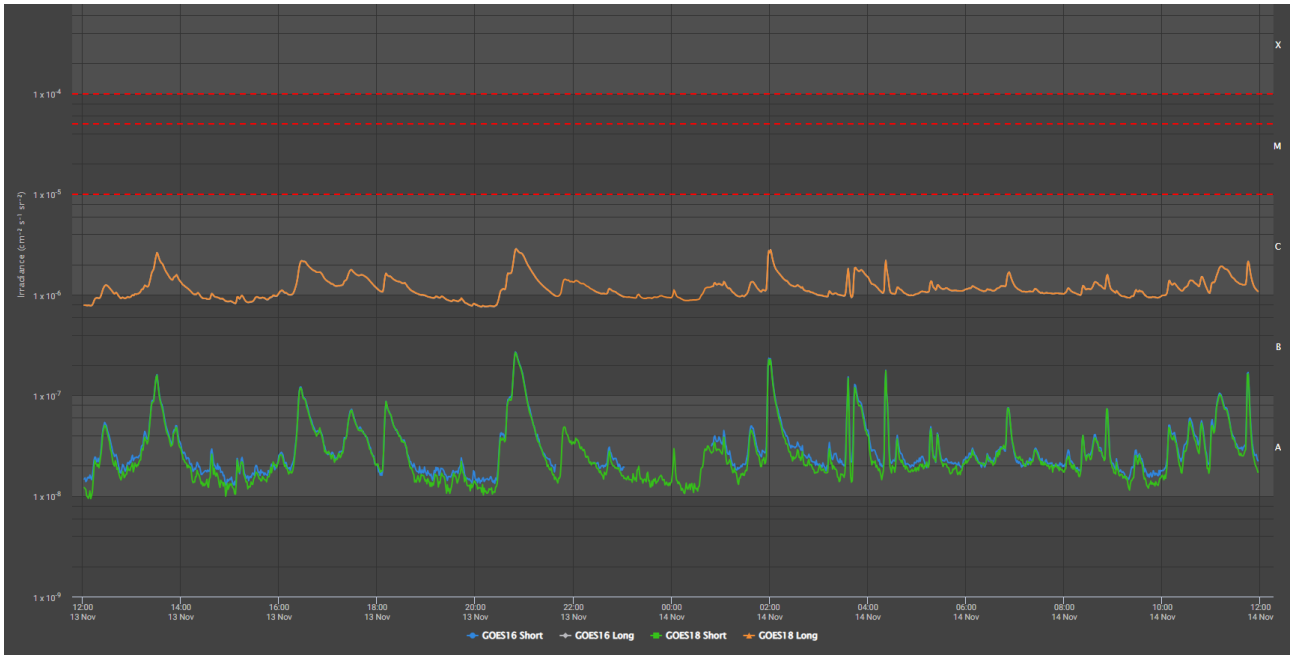
Radio Blackouts - X-Ray Flares:
There are five sunspots currently on the visible solar disc, all of which lie on the western disc. AR3483 (Dho/Beta) close to the northwest limb is the largest region but can no longer be clearly seen. AR3484 (Eao/Beta) and AR3485 (Dso/Beta-Gamma) are both near the southwest limb and are also becoming difficult to assess, although AR3485 is showing some signs of developing minor magnetic complexity. AR3486 (Dsi/Beta) and AR3487 (Dri/Beta) are both relatively straightforward at the present time.

AR3483 and AR3484 will rotate beyond the western limb towards the end of Day 1 (14 Nov), with AR3485 by Day 3 (16 Nov). The viewing angle of these regions will become increasingly limited as they approach the western limb with their classification likely to be maintained as they rotate off the disc. Far-sided soundings, persistence and flux looping all suggest limited contributions from any new or returning regions over the eastern limb during the period. The result is, that in the absence of significant sunspot development, the risk of M-class flares decreases during the period.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	30	25	20	15
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: X-ray trace from GOES16 and GOES18 showing just C-class flaring.



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Solar Radiation Storms - (High Energy Protons):
The high energy (greater than 10MeV) proton flux observed by GOES16 is currently at background levels. The sunspots that are currently located in the western hemisphere pose a slight chance of producing S1/Minor Radiation Storm conditions, but these are starting to rotate off the disc during the period. Probabilities begin to wane later in the period as these regions rotate well beyond the western limb.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	2	1
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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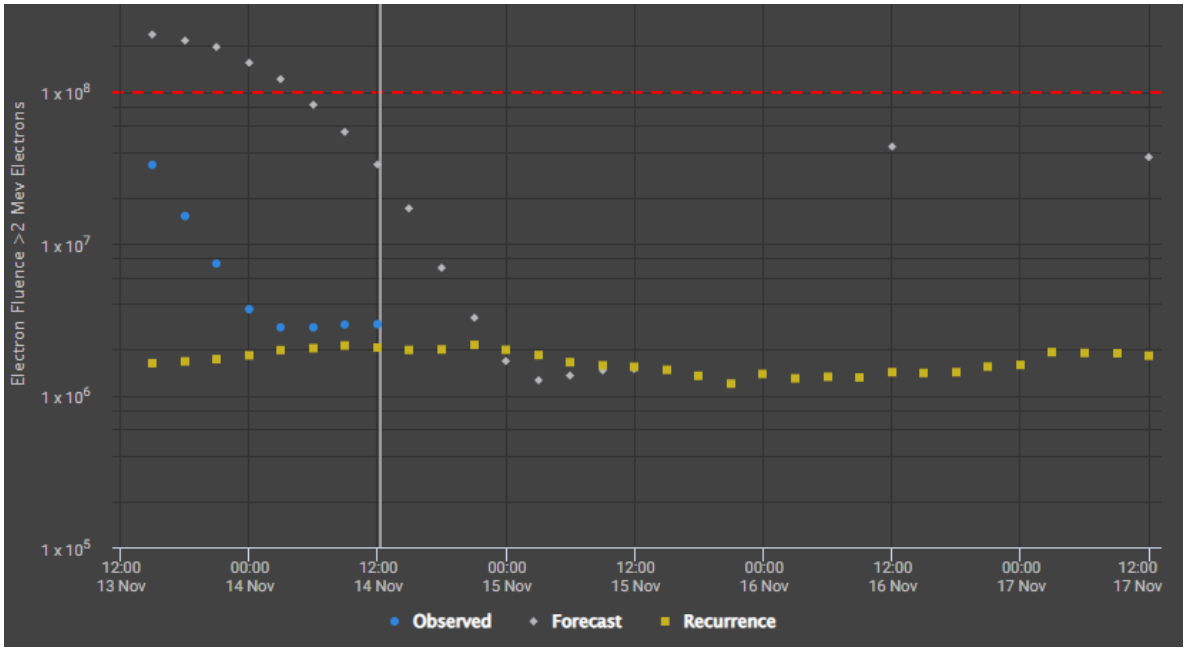
High Energy Electrons Event (≥ 2MeV):
High energy electron flux (greater than 2MeV) has been at high levels over recent days in response to the fast wind from CH67/-, but slowly declined after a CME arrival on 12 Nov. Further suppression of the electron belt may have transpired either due to weak effects from CH68/+ or a possible further weak CME arrival on 13 Nov.

There is low confidence in the behaviour of the electron flux in the coming days but we may see a relaxation of the radiation belt and an increase in the electron flux through Days 1-2 (14-15 Nov). This may then result in periods of High flux levels for the remainder of the period. The potential for a further weak CME glancing blow on Day 2 complicates the flux forecast, as this may suppress levels once again should it occur.

Electron fluence is now steady after a recent decline, but may recover towards Active levels from Day 2 onwards in response to the forecast increased electron flux. There is low confidence in the extent of any Active periods due to uncertainty in the electron flux and geomagnetic forecasts. MOSWOC REFM is suggesting an increase towards Active fluence Days 3-4 (16-17 Nov), but REFM has been performing poorly of late.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	10	30	50	50
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 4: MOSWOC REFM showing a recovery in fluence levels below Active, but this is low confidence.



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